APPENDIX II:

CURRENT MONITORING IN THE GREATER YELLOWSTONE NETWORK PARKS AND SURROUNDING LANDSCAPES

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Air and Climate

AIR QUALITY

Atmospheric Deposition Monitoring

Atmospheric deposition monitoring is ongoing in YELL through two major programs: the National Atmospheric Deposition Program/National Trends Network (NADP/NTN) and the Clean Air Status and Trends Network (CASTNET). NADP is a multi-agency (including federal, state and local) approach to monitoring the chemistry of wet deposition throughout the country at over 200 sites (NADP 2004). The NADP/NTN program currently operates one station at Tower Falls in Yellowstone National Park Data collected from this site can be downloaded from: http://nadp.sws.uiuc.edu/sites/siteinfo.asp?id=WY08&net=NTN and includes information on daily, weekly, seasonal and annual totals and trends for the site (NADP 2004). NADP also operates a Mercury Deposition Network (NADP/MDN) that collects information on weekly total mercury concentrations in precipitation, as well as seasonal and annual mercury flux. An MDN station was started at Yellowstone Lake in February 2002 and moved to Tower in 2004. All available data can be downloaded from the following website: http://nadp.sws.uiuc.edu/sites/siteinfo.asp?id=WY07&net=MDN.

The U.S. Geological Survey, along with the National Park Service-Air Resources Division, U.S. Forest Service and other agencies jointly operate the Rocky Mountain Snowpack Chemistry Network to determine the quality of precipitation and to identify sources of atmospherically deposited pollution. The RMS was created to augment NADP/NTN stations at high elevations (Nanus et al. 2003) and includes sites in Grand Teton and in Yellowstone (Ingersoll et al. 2001). The results of the first 5 years are summarized in a report by Ingersoll et al. (2001) available at http://water.usgs.gov/pubs/of/2001/ofr01-466.

As part of the Clean Air Status and Trends Network program (CASTNET [EPA 2004]), the U.S. Environmental Protection Agency (EPA) has been monitoring atmospheric deposition in YNP since 1996. CASTNET is a joint venture between EPA and the National Park Service-Air Resources Division that operates over 70 dry acidic deposition sites throughout the U.S. These sites provide hourly data on ozone levels and weekly information on the concentration of sulfate, nitrate, ammonium, sulfur dioxide and nitric acid (EPA 2004). This EPA monitoring focuses on dry deposition at one site near Lake Village and data from this site can be downloaded at: http://www.epa.gov/castnet/sites/yel408.html.

Literature Cited

EPA (Environmental Protection Agency), 2004. Overview of CASTNET Program. Available at: http://www.epa.gov/castnet/overview.html.

Ingersoll GP, Turk JT, Mast MA, Clow DW, Campbell DH, Bailey ZC. 2001. Rocky Mountain Snowpack Chemistry Network: History, Methods, and the Importance of Monitoring Mountain Ecosystems. U.S Geological Survey Open File Report 01-466, 14 p.

Nanus L, Campbell DH, Ingersoll GP, Clow DW, Mast MA. 2003. Atmospheric deposition maps for the Rocky Mountains. Atmospheric Environment 37: 4881–4892.

National Atmospheric Deposition Program (NADP). 2004. NADP history and overview. <http://nadp.sws.uiuc.edu/nadpoverview.asp>. Accessed 2004 Jul 15.

Oversnow emissions

Yellowstone National Park funded an air pollutant 'emission' study in 2003 as part of the park's ongoing efforts to monitor air quality and other park resources to assess the impacts of winter use. The study collected over 200 air samples from 21 sites throughout Yellowstone from February 12-16, 2003, using well-recognized methods accepted by the Environmental Protection Agency. Scientists at University of New Hampshire measured approximately 85 different Volatile Organic Compounds (VOCs) including benzene and toluene, as well as carbon monoxide and methane. The study is available at: *www.nps.gov/yell/technical/planning/winteruse/plan/*.

Ozone

Historic Monitoring
Passive ozone monitoring was conducted from1995 through 2004 to determine ozone exposure levels. Data collected from this site can be downloaded from: http://www2.nature.nps.gov/air/studies/passives.htm. Passive ozone monitoring is an inexpensive method that involves exposing the passive sampler to ozone on a weekly basis during the "ozone season" from May to September. After exposure, the sampler is retrieved and mailed to a contract lab for analysis. The passive ozone monitoring program was supervised and funded by the NPS-ARD and was discontinued in 2004.

Visibility Monitoring

Visibility monitoring is ongoing in Yellowstone and Grand Teton National Parks as part of the Interagency Monitoring of Protected Visual Environments (IMPROVE) program. IMPROVE is composed of members from federal, state and regional agencies and has the common goal of providing information to protect visual environments under the Clean Air Act of 1977 (IMPROVE 2004). The program was initiated in 1985 to protect visibility in Class I airsheds in 156 national parks and wilderness areas.

The objectives of the IMPROVE program are: "to establish current visibility and aerosol conditions in mandatory class I areas; to identify chemical species and emission sources responsible for existing man-made visibility impairment; to document long-term trends for assessing progress towards the national visibility goal; and with the enactment of the Regional Haze Rule, to provide regional haze monitoring representing all visibility protected federal Class I areas where practical" (IMPROVE 2004). The website can be accessed at: http://vista.cira.colostate.edu/improve/Overview/Overview.htm and contains downloadable data (including aerosol, light extinction and scatter, and scenes) at: http://vista.cira.colostate.edu/improve/Data/data.htm.

Literature Cited
Interagency Monitoring of Protected Visual Environments (IMPROVE). 2004. Overview of IMPROVE and visibility. <http://vista.cira.colostate.edu/improve/Overview/Overview.htm>. Accessed 2004 Jul 14.

WEATHER

Climate

Climate monitoring is currently occurring in all three park units of the GRYN. Gray (2005) prepared a monitoring protocol for the network that defines the climate metrics of interest, the frequency of measurements and reporting units. Climate monitoring stations found within the parks of the GRYN include: the National Climatic Data Center (NCDC) climate stations found in Yellowstone and Grand Teton and north of Bighorn Canyon; the National Weather Service remote automated weather station (RAWS) in all parks; and Natural Resources Conservation Service Snotel and Snowcourse sites in Yellowstone and Grand Teton (Selkowitz 2003) and the Climate Reference Network station in Grand Teton. Much of this climate data is available online through the following Web sites (Gray pers. comm.):

- the Western Regional Climate Center provides detailed climate summaries for stations in the Western U.S. at: http://www.wrcc.dri.edu/climsum.html
- the National Oceanic and Atmospheric Administration NCDC provides access to hourly, daily and monthly climate data, and information on extreme events, at: http://www.ncdc.noaa.gov/oa/climate/climatedata.html
- select National Weather Service and cooperator station hourly climate data can be accessed through: http://www.ncdc.noaa.gov/oa/climate/climatedata.html#HOURLY at the following website for daily observations: http://hurricane.ncdc.noaa.gov/pls/plclimprod/poemain.accessrouter?datasetabbv=SOD and at the following website for monthly observations: http://hurricane.ncdc.noaa.gov/pls/plclimprod/somdmain.somdwrapper?datasetabbv=TD3220
- daily observation from the U.S. Historical Climatology Network can be accessed through: http://www.ncdc.noaa.gov/oa/climate/research/ushcn/daily.html and monthly observations can be accessed through: http://www.ncdc.noaa.gov/oa/climate/research/ushcn/ushcn.html. The HCN concentrates on providing long-duration, high-quality datasets (therefore, length of records may be shorter than with other services). HCN stations within the GRYN include Mammoth Hot Springs (Yellowstone) and Lake (Yellowstone).
- data from RAWS stations can be accessed through: http://www.met.utah.edu/jhorel/html/mesonet/
- data from the Climate Reference Network: http://www.ncdc.noaa.gov/crn/hourly.

The Climate Reference Network (CRN) station at GRTE, which was established in 2004, is funded by the National Oceanic and Atmospheric Administration (NOAA) and NCDC. The primary goal of the CRN is to provide future long-term, high-quality observations of surface air temperature and precipitation that can be coupled to past long-term observations for the detection and attribution of present and future climate change. Measures include air temperature, precipitation, solar radiation, wind speed, ground surface temperature and relative humidity.

Literature Cited

Gray ST. 2005. Climate Monitoring protocols for the Greater Yellowstone Network: Bighorn Canyon National Recreation Area, Grand Teton National Park (including J.D. Rockefeller, Jr. Memorial Parkway), and Yellowstone National Park. Draft Version 1. June 2005. National Park Service, Greater Yellowstone Network. 46 pp. plus appendices.

Selkowitz D. 2003. Compilation and analysis of climate data in the Greater Yellowstone Ecosystem/Bighorn Canyon Area: completed products, problems encountered and recommendations for the future final report to the Greater Yellowstone/Bighorn Canyon Vital Signs Network. Greater Yellowstone Inventory and Monitoring Network, National Park Service, Bozeman, MT. 5 pp.

Geology and Soils

GEOMORPHOLOGY

Stream Sediment Transport

Historic monitoring

Bed sediment was monitored as part of the USGS National Water-Quality Assessment (NAWQA) program. Bed sediment was sampled throughout the Yellowstone River Basin in 1998, specifically on the Bighorn River at Kane, Soda Butte Creek at park boundary, Yellowstone River at lake outlet and on the Yellowstone River at Corwin Springs (O'Ney and McCloskey 2004). These NAWQA stations are co-located with USGS gaging stations. Information on the NAWQA program and data retrievals can be found on the USGS NAWQA website by visiting http://wy.water.usgs.gov/YELL/htms/data.htm.

Literature Cited

O'Ney SE and McCloskey K, eds. 2004. Water quality monitoring plan, phase II report. National Park Service, Greater Yellowstone Network, Bozeman , MT. 51 pp. plus appendices.

Glaciers

Glacier and snowfield monitoring has focused primarily on synoptic studies at GRTE. In particular, estimates of summer and winter mass balance have been combined with remote sensing data to track the dynamics of key glaciers in the Teton Range (e.g., Elder et al. 1994). Related modeling experiments have also produced forecasts for the response of GRTE glaciers to future climate variability and change (e.g., Plummer and Cecil 2005).

Plummer MA and Cecil LD. 2005. Simulated response of two Wyoming glaciers to projected climate change. Proc. of the 1st Annual MTNCLIM Meeting, March 2005, Pray, Montana.

Elder K, Fullerton S, Tonnessen K. 1994. Winter mass balance measurements on Teton Glacier, Grand Teton National Park. Park Science 14:11-13.

Subsurface Geologic Processes

Seismic Activity Monitoring

Seismic activity has been monitored in Yellowstone since 1973 (USGS [Pitt 1987]). In 2001, the Yellowstone Volcano Observatory (YVO), a joint venture among the USGS, Yellowstone National Park and the University of Utah, was created as part of the USGS Volcano Hazards Program in an effort to facilitate collaborative monitoring and research of geologic processes associated with the Yellowstone volcano (Olliff 2002). Dr. Jake Lowenstern of the USGS is Scientist-in-Charge of YVO, with coordination from scientists Dr. Bob Smith of the University of Utah and Dr. Hank Heasler of Yellowstone National Park (YVO 2004). Real-time data available on the YVO website include: earthquake data, such as live seismographs, earthquake catalogs (including maps) and a recent history of earthquakes in the area; GPS deformation data, which shows coordinates of spatial variations in the ground due to "magma and hydrothermal transport and fault motions related to earthquakes"; and hydrologic data gathered by the USGS, which includes chloride flux, stream discharge, water temperature and streamflow data (YVO 2004). These data can be accessed at: http://volcanoes.usgs.gov/yvo/monitoring.html. The University of Utah Seismograph Stations (UUSS) Network maintains the following types of monitoring stations in the Yellowstone Seismic Network: 17 short-period, vertical-component, analog telemetry; 2 short-period, three-component, analog telemetry; 2 broadband, three-component, analog telemetry; 1 broadband, three-component, digital telemetry. Funding for the UUSS is mostly provided by the USGS (95%) with some contribution from the National Park Service (5% [UUSS 2004]). Live seismographs from the Yellowstone Seismic Network can be seen at: http://www.seis.utah.edu/helicorder/heli/yellowstone/index.html. Meanwhile, current volcano activity reports can be accessed at the following website: http://volcanoes.usgs.gov/yvo/activity.html.

In order to better understand the geophysical processes at work in GRTE, a number of research and monitoring projects are taking place in the park. Three seismic monitoring stations and one continuously recording GPS receiver are currently in place at GRTE. Real-time data from the seismic monitoring network are available online as indicated for YELL with similar cooperation from the USGS and the University of Utah. Research projects related to geophysical processes include: studying the historic return time of earthquakes on the Teton fault, investigating the intermountain seismic belt as a system, and synthesizing monitoring data in hopes of improving earthquake prediction. As the West-wide Earthscope/Plate Boundary Observatory (PBO) project proceeds, GRTE and YELL may host 1-2 additional GPS units. The Earthscope Web site is found at: http://www.earthscope.org/pbo/index.shtml.

Literature Cited
Olliff T. 2002. Monitoring volcanic and earthquake unrest in Yellowstone. Pages 24-25 in Natural Resources year in Review 2001. J Selleck, ed. National Park Service, Natural Resource Stewardship and Science. WSO-NRID. 70 pp.

Pitt AM. 1987. Catalog of earthquakes in the Yellowstone Park-Hebgen lake Region, Wyoming, Montana, and Idaho, for the years 1973 to 1981. U.S. Department of the Interior, U.S. Geological Survey, Washington, DC.

University of Utah Seismograph Stations (UUSS). 2004. More about UUSS. <http://www.seis.utah.edu/behind/behind.shtml>. Accessed 2004 Jun 14.

Yellowstone Volcano Observatory (YVO). 2004. Volcano monitoring at Yellowstone National Park. <http://volcanoes.usgs.gov/yvo/monitoring.html>. Accessed 2004 Jun 14.

Chloride Flux Monitoring

In addition to monitoring seismic activity and geothermal features directly, Yellowstone also monitors proxies for geothermal activity, including groundwater temperature and chloride flux. High-temperature wells have been drilled throughout Yellowstone for research purposes, starting in 1931, and now consist of fifteen, with the majority drilled in the late 1960s (Heasler et al. 2003). The Yellowstone Spatial Analysis Center updated the inventory of these wells—many of them deteriorating due to hot, acidic geothermal water—in 2002 (Heasler et al. 2003). While they have been used for research purposes—particularly for understanding the impacts of geothermal development outside the park on park resources—there is currently no ongoing, long-term monitoring of groundwater temperature in these wells. Understanding groundwater temperature should give insights into the interaction between groundwater and geothermally influenced waters in the hydrologic system of Yellowstone (Heasler et al. 2003). Chloride flux, in contrast, has been monitored for almost two decades in the Fall, Snake, Madison and Yellowstone Rivers (Heasler et al. 2003). Chloride flux is used as an estimator of heat flow and geothermal activity, and approximately 94% of the chloride in Yellowstone's waters is thought to be from magmatic origin (Norton and Friedman 1985). According to Heasler et al. (2003), "water samples for chloride analysis are collected 28 times a year at river gauging stations: monthly during the winter at low flow, biweekly during the early spring and fall, and weekly during spring runoff." Analyses of these data have shown a 10% decrease in chloride flux over the past 19 years, which may be due to deflation of the caldera (Heasler et al. 2003).

<u>Literature Cited</u>

Heasler H, Jaworowski C, Susong D. 2003. A geothermal monitoring plan for Yellowstone National Park. National Park Service, Yellowstone National Park, Mammoth Hot Springs, Wyoming. 23 pp.

Norton D, Friedman I. 1985. Chloride flux out of Yellowstone National Park: Journal of Volcanology and Geothermal Research, v. 26, p. 231-250.

Geothermal Feature Monitoring

Monitoring of geothermal features in Yellowstone has been performed in the past when personnel and funds were available. Monitoring has been mostly qualitative in nature and can be found in various Yellowstone National Park archives, internal reports and notebooks (Heasler et al. 2003). An inventory of over 7,000 geothermal features was compiled by the YELL Spatial Analysis Center from 1999-2003; this represents only 60-70% of the total features contained within the park (Heasler et al. 2003). Monitoring of geothermal features generally takes one of two forms, depending on the location of the feature and available funding: features may be monitored in-depth, including collecting data on "temperature, flow, chemistry of water and gases (major anions, cations, metals, trace elements, isotopes, etc.) and spatial extent (using techniques such as photographic surveying methods)," or they may be monitored using remote sensing techniques (Heasler et al. 2003). Yellowstone National Park is currently obtaining funding for in-depth monitoring and remote sensing to be included in the plan for monitoring geothermal resources in the park (Heasler et al. 2003). However, in addition to the informal monitoring of geothermal features, data collection on eruption intervals is ongoing at the Old Faithful Geyser by park interpretive staff, and a volunteer monitors vandalism to features in the Upper, Midway and Lower Basins (Jean et al. 2003). A list of geyser activity—updated in 2002 and including the interval between eruptions and the height of the eruption—can be found at the following website: http://www.nps.gov/yell/nature/geothermal/ycr/activity.html. USGS researchers completed mapping the bottom of Yellowstone Lake in summer 2003 using multibeam sonar imaging and seismic mapping. This mapping revealed an "inflated plain" that rises 100 feet from the lake bottom and is about 2,000 feet long (YVO 2004). While this bulge could possibly lead to a hydrothermal explosion, indications from recent monitoring suggest that this is unlikely in the near future (YVO 2004). The Yellowstone Volcano Observatory is monitoring the temperature of the hydrothermal vents and conducting an assessment of the geologic hazards in Yellowstone National Park (YVO 2004).

Literature Cited

Heasler H, Jaworowski C, Susong D. 2003. Geothermal monitoring plan for Yellowstone National Park. National Park Service, Yellowstone National Park, Mammoth Hot Springs, Wyoming. 23 pp.

Jean C, Bischke SD, Schrag AM. 2003. Greater Yellowstone Inventory and Monitoring Network Vital Signs Monitoring Plan: Phase II Report, September 30, 2003. National Park Service, Greater Yellowstone Network, Bozeman, MT. 99 pp. plus appendices.

Yellowstone Volcano Observatory (YVO). 2004. Frequently asked questions about recent findings at Yellowstone Lake. <http://volcanoes.usgs.gov/yvo/new.html>. Accessed 2004 Jul 14.

Water

Water Chemistry

Historic monitoring efforts

Water quality monitoring in the GRYN parks has taken place for several decades. Most monitoring is done as synoptic studies of limited duration (e.g., the EPA EMAP program (2000-2003). The USGS National Water Quality Assessment (NAWQA) program established eight water quality monitoring stations in or near the network parks between 1998 and 2001; these stations are included in the Yellowstone River Basin and upper Snake River Basin study units, both of which were scheduled for the second assessment cycle during this decade (USGS 2001);

however, the focus and sample locations may change, depending on agency goals. At Yellowstone, NAWQA parameters measured included: biological parameters, nutrients, organics, major inorganics, minor and trace elements, physical properties, radio-chemicals and sediment (O'Ney and McCloskey 2004). There were two NAWQA stations in GRTE, Flagg Ranch established in the early 1990's and one at Moose, established in 1996. Parameters measured quarterly included: water temperature, pH, dissolved oxygen, specific conductivity, nutrients and suspended sediment (O'Ney and McCloskey 2004). These parameters were also measured at the NAWQA stations located in or adjacent to Bighorn Canyon NRA. In additional, fecal coliforms were monitored on the Bighorn River at Kane and on the Shoshone River near Lovell (O'Ney and McCloskey 2004) during the NAWQA assessment. Refer to USGS Web site http://water.usgs.gov/nawqa/constituents/ for detailed descriptions of parameters measured by the NAWQA protocols.

Surface water quality data retrievals from six of the EPA's national databases served as the basis for the Baseline Water Quality Data Inventory and Analysis Reports completed for YELL, GRTE and BICA by the Servicewide Inventory and Monitoring Program and the Water Resources Division (National Park Service 1994, 1998b, 2001). These data were later acquired and analyzed for state water quality exceedances by Woods and Corbin (2003a, 2003b, 2003c). Knauf and Williams acquired and analyzed seven data sets for Soda Butte Creek (2005), dating from 1987 to 2001; these data were submitted to EPA for submission to the EPA STORET database. In 2004 the GRYN prepared a phase II Water Quality Monitoring Plan (O'Ney and McCloskey 2004) to address overall water quality goals, background information and conceptual models for water quality monitoring in the GRYN. These reports are located on the GRYN Web page http://www.nature.nps.gov/im/units/gryn/index.shtml.

Current monitoring effort

The following section describes water quality monitoring currently being done by the YELL aquatics section in YELL and by park staff at GRTE. See also sections on geothermal and streamflow monitoring for more information on other water-related monitoring.

Both YELL and GRTE have ongoing water quality monitoring within their boundaries. At the USGS gaging station at Moose (GRTE), there is a real-time, continuous monitor for water temperature, pH, dissolved oxygen and specific conductivity. Also in GRTE, approximately 20 groundwater wells adjacent to sewage ponds and leach fields within park boundaries are presently being monitored once a year for basic water quality parameters, fecals and nutrients to comply with the requirements of Wyoming Department of Environmental Quality. Additionally, Snake River Pit ground water levels are monitored on a biweekly basis from wells installed by the USGS in 1997 (O'Ney and McCloskey 2004). Testing for fecal coliform, including DNA source tracking of *E. coli*, to determine the mammalian source of coliforms, began in 1996 in selected backcountry streams and has continued to date (O'Ney and McCloskey 2004).

A long-term water quality monitoring program was started in YELL in 2002 and includes nineteen fixed sites; twelve of these stations are located on rivers and streams and seven are located on Yellowstone Lake. Field measurements include: pH, dissolved oxygen, specific conductance, temperature and turbidity; samples are collected for total suspended solids (TSS) and volatile suspended solids. Sampling takes place at two-week intervals during the spring, summer and fall and monthly during the winter (December, January and February). On Yellowstone Lake, monitoring stations were established at four historic sampling stations (Koel et al. 2004), with sampling taking place between May and October (during ice-free periods). Two additional sampling sites on the southern arms of Yellowstone Lake were added in 2003 for a total of seven stations on the lake.

In 2005 the GRYN began monitoring water bodies identified as water quality impaired: Soda Butte Creek and the Bighorn River in Montana and the Shoshone River in Wyoming. The Regulatory Water Quality Monitoring Protocol for the Greater Yellowstone Network (O'Ney 2005) establishes the standing operating procedures for measuring core parameters and discharge plus dissolved and total metals in water and metals in sediment (on Soda Butte Creek), nutrients (on the Bighorn River) and *E.coli* and fecal coliforms (on the Shoshone River). Macroinvertebrates are also monitored at least once a year at each of these three stations.

<u>Literature Cited</u>

Knauf M, Williams MW. 2004. Soda Butte Creek and Reese Creek: Vital Signs Monitoring Program, Final Report. National Park Service, Greater Yellowstone Network, Bozeman, MT. 29 pp. plus appendices.

Koel TM, Arnold JL, Bigelow PD, Doepke PD, Ertel BD and Mahony DL. 2004. Yellowstone Fisheries & Aquatic Sciences: Annual Report, 2003. National Park Service, Yellowstone Center for Resources, Yellowstone National Park, Wyoming, YCR-NR-2004-03.

National Park Service. 1994. Baseline Water Quality Data Inventory and Analysis. Yellowstone National Park. Technical Report NPS/NRWRD/NRTR-94/22.

National Park Service. 1998b. Baseline Water Quality Data Inventory and Analysis. Bighorn Canyon National Recreation Area. Technical Report NPS/NRWRD/NRTR-98/164.

National Park Service. 2001. Baseline Water Quality Data Inventory and Analysis. Grand Teton National Park. Technical Report NPS/NRWRD/NRTR-2000/260.

O'Ney SE and McCloskey K, eds. 2004. Water quality monitoring plan, phase II report. National Park Service, Greater Yellowstone Network, Bozeman , MT. 51 pp. plus appendices.

O'Ney SE. 2005. Regulatory water quality monitoring protocol. Version 1.0. Bozeman (MT): National Park Service, Greater Yellowstone Network. 35 pp. plus appendices.

United State Geological Survey, 2001. The National Water – Quality Assessment Program – Entering a new decade of investigations. USGS Fact Sheet 071-01. July 2001. 6 pp.

Woods SW, Corbin J. 2003a. Vital signs water quality monitoring for the Greater Yellowstone Network: Bighorn Canyon National Recreation Area: Final Technical Report, July 2003. National Park Service. Greater Yellowstone Network, Bozeman, MT.

Woods SW, Corbin J. 2003b. Vital signs water quality monitoring for the Greater Yellowstone Network: Grand Teton National Park: Final Technical Report, August 2003. National Park Service. Greater Yellowstone Network, Bozeman, MT.

Woods SW, Corbin J. 2003c. Vital signs water quality monitoring for the Greater Yellowstone Network: Yellowstone National Park: Final Technical Report, September 2003. National Park Service. Greater Yellowstone Network, Bozeman, MT.

Water temperature

Continuous water temperature is currently being monitored by the USGS at gaging stations on the Gibbon, Firehole and Snake River (at Moose) and on Soda Butte and Tantalus Creeks. In addition, the YELL geothermal monitoring program has an extensive network of temperature loggers scattered throughout the park.

HYDROLOGY

Streamflow

Streamflow (real-time discharge and gage height) is being monitored by the USGS at several gages at flowing rivers throughout the GRYN (see Table 1). Stream gage stations are located on the Madison, Gibbon, Firehole, Gallatin, Yellowstone, Lamar, Gardner, Boiling, Bighorn, Shoshone, Gros Ventre and Snake Rivers; and on Granite, Buffalo Fork, Pacific, Tantalus and Soda Butte Creeks (Table 1). Data can be obtained from http://waterdata.usgs.gov/nwis.

These gages are usually located on the main stem of larger rivers at easily accessible sites. While this network provides invaluable information on regional hydroclimatic variability, the lack of gages in headwaters areas or on smaller tributaries may represent an important data gap for the GRYN. Smaller streams generally respond more rapidly to variations in climate (NAST 2001; Wagner 2003). Small streams also provide key habitats for species of interest within the GYE (e.g., cutthroat trout).

Table 1. Key stream gages for the GRYN parks.

USGS_Station_Name	USGS Station_ID	Data_Collected by USGS	Period_of_USGS_Record
Madison River near West Yellowstone MT	06037500	Real time discharge, gage height	1913-present
Yellowstone River at Yellowstone Lk Outlet YNP	06186500	Real time discharge, gage height; NAWQA	1926-present
Soda Butte Cr nr Lamar Ranger Station YNP	06187950	Real time discharge, gage height, air temperature	1888-89; 1990-present
Lamar River nr Tower Falls Ranger Station YNP	06188000	Real time discharge, gage height	1923-present
Gardner River near Mammoth YNP	06191000	Real time discharge, gage height	1938-present

Boiling River at Mammoth, YNP	06190540	Real time discharge, gage height;	1988-1995; 2002-present
Yellowstone River at Corwin Springs MT	06191500	Real time gage height, discharge, air temperature; NAWQA	1889-1893; 1910-present
Firehole River near West Yellowstone MT	06036905	Real time discharge, gage height, water temperature	1983-1996 (discharge); 2002-present
Gibbon River at Madison Jct, YNP	06037100	Real time gage height, discharge, water temperature	2000-present
Soda Butte Cr at Park Bndry at Silver Gate	06187915	Real time discharge, water temperature, gage height; NAWQA	1999-present
Tantalus Creek at Norris Junction, YNP	06036940	Real time gage height, discharge, precipitation, water temperature	6/25/2004-present
Snake River AT Moose, WY	13013650	Real time discharge, gage height, water temperature, specific conductivity, dissolved oxygen, pH; NAWQA protocols	1995 to present
Snake River AB Jackson Lake at Flagg Ranch WY	13010065	Real time gage height, discharge; NAWQA;	1983 to present; prior to 1988 pub as 13010200
Snake River NR Moran WY	13011000	Real time discharge, gage height;	1903 to present
Pacific Creek at Moran WY	13011500	Real time gage height, discharge;	1906 to 1917; 1944 to 1975; 1978 to current year
Buffalo Fork AAB Lava Creek NR Moran WY	13011900	Real time gage height, discharge;	1965 to present
Gros Ventre River at Zenith WY	13015000	Real time gage height, discharge	July-Sept. 1917 and 1918; October 1987 to present
Granite C AB Granite C Supplemental, NR Moose, WY	13016305	Real time discharge, gage height;	1995 to present
Bighorn River at Kane, WY	06279500	Real time discharge, gage height; NAWQA	1928-present
Bighorn River near St. Xavier, MT	06287000	Real time discharge, gage height;	1934-present
Shoshone River near Lovell, WY	06285100	Real time discharge, gage height;	1966-present

http://waterdata.usgs.gov/nwis

Literature Cited

NAST (National Assessment and Synthesis Team), 2001. *Climate Change Impacts on the United States: The Potential Consequences of Climate Variability and Change.* Report for the U.S. Global Change Research Program, Cambridge University Press, Cambridge, UK.

Wagner FH. (ed.), 2003. *Rocky Mountain/Great Basin Regional Climate Change Assessment. A Report of the Rocky Mountain/Great Basin Regional Assessment Team for the U.S. Global Change Research Program.* Utah State University, Logan, UT.

Lake and Reservoir elevation

The Bureau of Reclamation also continuously monitors the lake levels of Bighorn and Jackson Lakes. Data for Jackson Lake Reservoir may be found at: http://www.usbr.gov/pn/hydromet/burtea.cfm . Data for Bighorn Lake may be found at: http://www.usbr.gov/gp/htbin/hydromet_teacup?BH.

Biological Integrity

INVASIVE SPECIES

Invasive Plants

Invasive plant monitoring is largely taking place through repeat inventories across the network. At Bighorn Canyon NRA, a subset of high priority invasive plants have been mapped or inventoried (via transects) in all management areas. Major paved roads are treated several times a year for invasive plants followed by informal walk-through surveys to monitor treatment effectiveness. Walkthrough effectiveness surveys are also conducted at other significant weed treatment areas within the NRA (Pickett, pers. comm. 2004).

At Grand Teton NP nearly all invasive plant species have been mapped throughout the Park using a variety of survey methods. A few infestations (orange hawkweed, Dyer's woad, sulphur cinquefoil) that have been treated through mechanical (e.g. hand pulling, mowing) or chemical means are being monitored for treatment effectiveness. Several biological exotic plant control agents have been released in the Park over the last 9 years, and long-term monitoring transects have been installed on all release sites (Haynes and Janssen, pers, comm., 2004).

At Yellowstone annual monitoring of high priority invasive plant species along roads and in developed areas began in the early 1990's (Olliff and others 2001). Informal walk-through surveys are conducted along roadsides to monitor population trends as well as treatment effectiveness. Infestations are classified by density classes (low, medium, high). Opportunistic surveys for exotic plants are also conducted in other areas of YELL by backcountry Rangers (Renkin, pers. comm. 2004). In addition, Dalmatian toadflax was surveyed and monitored in the Mammoth Hot Springs area in the mid-1970's.

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Janssen, Eric. Telephone conversation with: Elizabeth Crowe. 2004, Jul 8.

Olliff T, Renkin R, McClure C, Miller P, Price D, Reinhart D, Whipple J. 2001. Managing a complex exotic vegetation management program in Yellowstone National Park. Western North American Naturalist 61(3):347-358.

Pickett, Bill. Telephone conversation with: Elizabeth Crowe. 2004, Jul 7.

Renkin, Roy. Telephone conversation with: Elizabeth Crowe. 2004, Jul 7.

INFESTATIONS AND DISEASE

Forest Insect and Disease Monitoring

Forest pest insects and diseases in the Greater Yellowstone Ecosystem are monitored by the Forest Health Protection (FHP) program (web address: http://www.fs.fed.us/foresthealth/), which is part of the State and Private Forestry section of the USDA-Forest Service. This program monitors long-term health, insects and pathogens by conducting low-elevation aerial surveys on all federal and state forested lands (Harris pers. comm.). The GYE is completely surveyed approximately every three years. More frequent surveys, however, are conducted in areas of high priority, and YELL has been surveyed in 2002, 2003 and 2004. Outbreaks and expansions of forest insect pests and diseases detected in the aerial surveys are mapped and reported to state and Federal forest management agencies (e.g. NPS, U.S. Forest Service, Wyoming Dept. of Forestry). Some ground surveys are also conducted by FHP entomologists and pathologists to follow up on severe infestations. FHP does not survey BICA currently, but does monitor the nearby Custer and Bighorn National Forests. Reports on forest insect and diseases conditions are released yearly. Regional reports can be found at (http://www.fs.fed.us/foresthealth/current_conditions.shtml) and state reports can be found at (http://www.na.fs.fed.us/spfo/fhm/fhh/fhmusamap.htm).

Transects to survey for the presence of blister rust in whitebark pine throughout YELL were placed in 1957 and have been monitored as recently as 1995 (Kendall and Keane 2001). In 2004 protocols for future whitebark pine monitoring are being piloted in YELL and surrounding national forests (see Whitebark Pine Monitoring Plan and Protocols).

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VERTEBRATE DISEASE

Numerous diseases are known to affect – or have the potential to affect – vertebrates living or migrating through the GRYN parks and, thus, current vertebrate disease monitoring efforts involve several state and federal agencies. USFWS and NPS scientists monitor brucellosis and numerous other pathogens in the Jackson bison and elk herds that range between the National Elk Refuge (NER) and GRTE. Some of this monitoring is in conjunction with Wyoming Game and Fish, which also surveys for Chronic Wasting Disease. The Jackson elk herd has been included in that surveillance since 2001.

At BICA the USGS recently completed a three-year mortality study of bighorn sheep that included a blood sampling for disease. The work was in response to a 1995 bighorn sheep decline that appeared consistent with disease propagation. The work, which did find evidence of Pasturella pneumonia, is complete with no current plans to extend into a regular monitoring program.

In YELL, disease monitoring is done by the Bison Ecology and Management Program, the Yellowstone Ungulate Program, the Wolf Recovery Program and the Fisheries Management Program and through partnerships and research activities of the Wildlife Conservation Society and the Yellowstone Ecological Research Center. Table 2 summarizes vertebrate disease monitoring underway in YELL.

Table 2. Vertebrate disease monitoring underway in Yellowstone National Park.

Host Species	Disease	Program	Data Source	Non-Park Contact	Park Contact	Reference
Cougar	Feline FIV Feline Parvovirus Feline coronavirus Canine calicivirus Canine distemper Plague Feline herpesvirus	YNP& Wildlife Conservation Society Cougar Research Program, 1987-present	Blood samples collected when animals captured for radio-collaring	Roman Biek Dept. Biology 1510 Clifton Rd Emory University Atlanta, GA 30322 Ph 404.727.9516 FAX 404.727.2880 rbiek@emory.edu	Kerry Murphy YCR POB 168 YNP, WY 82190 307.739.3321 kerry_murphy@nps.gov	Temporal dynamics and risk factors for microparasitic infections in free living cougars. Biek et al., submitted for publication
Coyotes	Canine distemper Canine parvovirus Canine Infectious Hepatitis Tularemia Leptospirosis Plague Fleas, ticks, mites, lice	YNP & Yellowstone Ecological Research Center Coyote Research Program, 1990 – present	Blood samples collected when animals captured for radio-collaring Ear swabs	Bob Crabtree YERC 2048 Analysis Dr. Bozeman, MT 59718 406.556.1414 crabtree@yellowstoneresearch.org	Kerry Murphy YCR POB 168 YNP, WY 82190 307.739.3321 kerry_murphy@nps.gov	Gese, E.M., R.D. Schultz, R. Johnson, E.S. Williams, R.L. Crabtree, and R.L. Ruff. 1997. Serological survey for diseases in free-ranging coyotes (Canis latrans) in Yellowstone National Park, Wyo. J. Wildl. Diseases 33:47-56.
Red Fox	Canine distemper Canine parvovirus Canine Infectious Hepatitis Tularemia Leptospirosis Plague Fleas, ticks, mites, lice	YNP & Yellowstone Ecological Research Center Coyote Research Program, 2002 – present	Blood samples collected when animals captured for radio-collaring Ear swabs	Bob Crabtree YERC 2048 Analysis Dr. Bozeman, MT 59718 406.556.1414 crabtree@yellowstoneresearch.org	Kerry Murphy YCR POB 168 YNP, WY 82190 307.739.3321 kerry_murphy@nps.gov	No references provided
Bats	Rabies	YNP Pest Management Program, periodic as needed	Whole carcass pathology	na	Roy Renkin YCR POB 168 YNP, WY 82190 307.344.2161 roy_renkin@nps.gov	No references provided
Birds	West Nile Virus	Periodic surveillance as needed	Whole carcass pathology	na	Terry McEneaney YCR POB 168 YNP, WY 82190 307.344.2222 terry_mceneaney@nps.gov	NPS IMR West Nile Virus Compendium and Checklist, September 2002
Cutthroat Trout	Whirling disease, Other fish diseases as encountered	YNP Fisheries Management Program	Whole carcass pathology	na	Todd Koel YCR POB 168 YNP, WY 82190 307.344.2281	Koel, T.M., D.L. Mahoney, L. Kinnan, C. Rasmussen, C.J. Hudson, S. Murcia, and B.L. Kerans. In press. Myxobolus cerebalis in native cutthroat trout of the

					todd_koel@nps.gov	Yellowstone Lake ecosystem. Transactions of the American Fisheries Society. Koel, T.M., J.L. Arnold, P.E. Bigelow, P.D. Doepke, B.D. Ertel, and D.L. Mahoney. 2004. Yellowstone Fisheries and Aquatic Sciences: Annual Report, 2003. National Park Service, Yellowstone Center for Resources, YNP, WY, YCR-NR-2004-03.
Gray Wolf	Rabies Canine distemper Canine parvovirus Brucella canis	YNP Wolf Recovery Program, 1995-present	Blood samples collected when animals captured for radio-collaring	na	Doug Smith YCR POB 168 YNP, WY 82190 307.344.2242 doug_smith@nps.gov	YNP Wolf Project 2003 Annual Report. YNP, WY.
Bison	Brucellosis	YNP Bison Ecology and Management Program, 2000-present	Blood samples collected when animals are captured	na	Rick Wallen YCR POB 168 YNP, WY 82190 307.344.2207 rick_wallen@nps.gov	Cheville, N.F., D.R. McCullough, L.R. Paulson. 1998. Brucellosis in the Greater Yellowstone Area. National Academy Press, Washington, DC, 186 pp.
Elk (adult females)	Bovine viral diarrhea virus Parainfluenza-3 virus Respiratory syncytial virus Epizootic hemorrhagic disease Paratuberculosis (Johne's disease) Chlamydia Leptospirosis Lungworm	Yellowstone Ungulate Program, 2001	Blood samples collected when animals are captured	Mark Boyce Department of Biological Sciences University of Alberta Edmonton, Alberta Canada T6G 2E9 Ph 780.492.0081 FAX 780.492.9234 boyce@ualberta.ca	P.J. White YCR, POB 168 YNP, WY 82190 307.344.2442 pj_white@nps.gov	No references provided
Elk calves	Bovine viral diarrhea Infectious bovine rhinotracheitis Respiratory synctial virus Brucellosis Parainfluenza-3 virus	Yellowstone Ungulate Program, 2003-2005	Blood samples collected when animals are captured	L. David Mech U.S. Geological Survey, BRD The Raptor Center, 1920 Fitch Ave University of Minnesota St. Paul, MN 55108 Ph 651.649.5231 FAX 651.649.5233 Mechx002@tc.umn.edu	P.J. White YCR, POB 168 YNP, WY 82190 307.344.2442 pj_white@nps.gov	No references provided
Pronghorn	Chlamydia Parainfluenza-3 virus Brucellosis Bovine viral diarrhea Respiratory synctial virus Bluetongue virus/Epizootic	Yellowstone Ungulate Program, 1999	Blood samples collected when animals are captured		P.J. White YCR, POB 168 YNP, WY 82190 307.344.2442 pj_white@nps.gov	Keating, K. 2002. History of pronghorn population monitoring, research, and management in Yellowstone National Park. Unpublished report dated January 28, 2002, and submitted to the National Park Service by the USGS Northern Rocky Mountain Science Center, Bozeman, Montana. NPS Agreement

	hemorrhagic disease virus Paratuberculosis (Johne's disease) Leptospirosis					#1443-IA-1248-01-006.
Bighorn Sheep	Lungworm	Yellowstone Ungulate Program, 2004	Fecal samples collected during winter on Mt. Everts		P.J. White YCR, POB 168 YNP, WY 82190 307.344.2442 pj_white@nps.gov	No references provided

FOCAL SPECIES OR COMMUNITIES

Aspen

Following the fires of 1988, Roy Renkin and Don Despain established 15 aspen seedling monitoring sites in various habitats in the northern half of the park (Renkin and Despain 1996). Other long-term aspen monitoring transects (112 in total) were established in 1999 and re-read in 2001 to study landscape-level trends in aspen dynamics, especially with regard to the effect of wolves on elk browsing behavior (Ripple et al. 2001). These transects were scheduled to be re-surveyed in 2004 (Renkin pers. comm.). In GRTE and BICA no monitoring of aspen is currently being conducted.

Literature Cited

Renkin R, Despain DG. 1996. Notes on postfire aspen seedling establishment. In: Greenlee JM, editor. Second biennial conference on the Greater Yellowstone Ecosystem; 1993, September; Yellowstone National Park. International Association of Wildland Fire. p 105-106.

Ripple WJ, Larsen EJ, Renkin RA, Smith DW. 2001. Trophic cascades among wolves, elk and aspen on Yellowstone National Park's northern range. Biological Conservation 102: 227-234.

Riparian Monitoring

In Yellowstone National Park, ungulate exclosures constructed from 1957-62 have provided opportunities for long-term vegetation monitoring of vascular plants and riparian communities. Past monitoring has involved repeat photography, rather than site measurements, as a monitoring tool (Kay 1990, Meagher and Houston 1998). Transects installed in willow communities between 1985-1987 have been monitored periodically (Singer 1996, Singer et al. 1994). Another cycle of monitoring these transects started in 2003 and will continue until 2007. A new set of monitoring transects in willow communities are being installed in 2004. The focus of all current willow monitoring is use by ungulates, especially how the reintroduced wolf population has affected ungulate browse behavior. No long-term monitoring of riparian vegetation is currently occurring in BICA or GRTE. A thesis project carried out in 1988 examined changes in riparian vegetation composition along the Bighorn River with BICA from 1938-1986 (Akashi 1988).

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Meagher MM, Houston DB. 1998. Yellowstone and the biology of time: photographs across a century. Norman, OK: University of Oklahoma Press. 287 p.

Singer FJ. 1996. Differences between willow communities browsed by elk and communities protected for 32 years in Yellowstone National Park. In: Singer FJ, editor. Effects of Grazing by Wild Ungulates in Yellowstone National Park. Denver, CO: U.S. Department of Interior, National Park Service. p 279-290.

Singer FJ, Mark LC, Cates RC. 1994. Ungulate herbivory of willows on Yellowstone's northern winter range. Journal of Range Management 47:435-443.

Canada Lynx

In March 2000, the USFWS listed the Canada lynx as a threatened species (USFWS 2000). Canada lynx were listed as threatened due to the inadequacy of forest plans to provide for protection of the ecological needs of lynx. National forest and park resource management plans have been amended, and a strategy is now in place for the conservation of lynx and their habitat. Threats include loss of connectivity between isolated ecosystems supporting lynx, incidental mortality during otherwise lawful trapping, hunting and snaring of other animals, and human encroachment on wildlands (USFWS 2003).

An inventory of Canada lynx in Yellowstone National Park was completed in 2004. Using a variety of survey methods, Canada lynx adults and kittens were detected in the park, with most detections occurring in an area near Yellowstone Lake that supports forests with dense understory vegetation (Murphy et al. 2004). It was concluded that the Canada lynx suffers from reduced population viability in the park, probably because the park represents the limit of its range (Murphy et al. 2004).

GRTE has completed a three-year study in collaboration with the Wildlife Conservation Society to determine (a) the status of lynx in the park, and (b) the activity of their primary prey, snowshoe hares. Results from these efforts will provide information for the determination of coarse-scale habitat requirements and, ultimately, what role Grand Teton plays in the overall conservation of lynx.

Black Bears *(Ursus americanus)*

Black bears occupy much of the same habitat as grizzly bears, although black bears tend to prefer areas that are closer to human occupation and at low- to mid-elevations (IGBST 2004). While previous work on black bears in the GYE has been limited to ground telemetry and home-range estimations, the IGBST has begun to monitor black bear demographics in YELL and GRTE to provide supplemental information to their grizzly bear monitoring efforts. This monitoring should lead to a better understanding of black bear habitat use, competition with grizzly bears and other predators, such as wolves, for limited food resources, and interactions with humans (IGBST 2004). To determine how black bears use the ecosystem, the IGBST collars randomly captured bears and locates them during grizzly bear telemetry flights. In addition, given ample time, the team visits feeding sites on the ground and collects data on vegetation and site characteristics (IGBST 2004).

Yellowstone National Park tracks bear management activities and posts annual updates on the following website: http://www.nps.gov/yell/nature/animals/bear/grizzlyup.html. The site contains information on numbers of sightings and signs reported by visitors and staff, first and last observation dates, bears that were captured, moved or euthanized, mortalities and food availability. Bear sightings reports are also posted every few weeks on the following website: http://www.nps.gov/yell/nature/animals/bear/index.htm.

Cougars (Puma *[Felis] concolor*)

After being nearly eliminated in the GYE in the early 20th century, the number of cougars in northern Yellowstone has fluctuated between 14 and 23 since 1987 (Ruth 2004). Cougar ecology has been monitored in two phases—one before and one after the reintroduction of wolves in Yellowstone—by the Hornocker Wildlife Institute, now part of the Wildlife Conservation Society, and in conjunction with the Yellowstone Wolf Project and the Interagency Grizzly Bear Study Team (Ruth 2004). The goals of this monitoring include understanding the following: cougar movement; habitat use in relation to wolves and bears; cougar demographics; predation rates of cougars, as well as cougar predation on other animals; denning data, including litter sizes and sex ratios; and genetic and disease analyses. Thus far, 65 adults, subadults and kittens have been radio collared and are monitored in an area of northern Yellowstone that corresponds with the ranges of 3-5 wolf packs (Ruth 2004).

Literature Cited

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Ruth TK. 2004. Ghost of the Rockies: the Yellowstone cougar project. Yellowstone Science 12(1): 13-17.

Ungulates

Under construction!!!

AT-RISK BIOTA

Bald Eagles

Significant increases in population numbers caused the USFWS to downlist the bald eagle from endangered to threatened in 1995 (McEneaney 2004). When the eagle was originally chosen as the national symbol in 1782, some 100,000 nesting pairs of bald eagles resided in the continental United States. By 1963, their numbers were down to 417 pairs (USFWS 1999). A loss of nesting habitat, coupled with the use of DDT and other organochlorines, which caused thinning of egg shells and decreased nesting success, lead to the decline in bald eagle populations (USFWS 1999). Captive breeding programs, reintroduction efforts, nest site protection and law enforcement helped in the recovery effort (USFWS 1999).

Although the eagle has now been downlisted, populations in the Great Lakes region and the desert southwest are still threatened by heavy metal contamination and habitat destruction, respectively (McEneaney 2004). In addition to the protection afforded by the Endangered Species Act, the bald eagle is also protected under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act (USFWS 1999).

Yellowstone National Park publishes an annual report documenting the population status, territorial occupancy and nest productivity of the bald eagle. Bald eagle monitoring has been ongoing in Grand Teton National Park since the 1970s, including ground surveys for nests and monitoring reproductive status at historical nests (Wolff 2003). Bald eagle nests south of Bighorn Canyon National Recreation Area are currently monitored by Wyoming Game and Fish and the Bureau of Land Management (D. Saville pers. comm.). This monitoring is mostly within the boundaries of the Yellowtail Wildlife Habitat Area, but also extends approximately 0.5 miles into BICA boundaries (B. Pickett pers. comm.). Please see Appendix III for links to reports and information on monitoring by the Greater Yellowstone Coordinating Committee outside the parks.

The Yellowstone National Park Bird Report began as a quarterly document and became an annual report in 1996. The reports can be accessed at the following website: http://www.nps.gov/yell/nature/animals/birds/birdreports.htm. In the 2003 Yellowstone Annual Bird Report, 32 active nests produced 24 fledged eaglets—the highest number in recorded history (McEneaney 2004). While the 1988 fires have not yet proved to be a detriment to bald eagle populations, falling trees may lead to nest failure and territory changes in the future (McEneaney 2004).

Much of the monitoring information on bald eagle status in GRTE, including nesting status, number of nestlings, and fledgling success, has not been recorded in approximately 30% of known nests due to staffing constraints in the past few years. In 2001, Science and Resource Management at GRTE identified eight historical nests and one new nest during a helicopter survey funded by the GRYN. GPS coordinates for nest sites were taken and will be used for monitoring in the future (Wolff 2003).

The Greater Yellowstone Bald Eagle Working Group, a subcommittee of the Greater Yellowstone Coordinating Committee, is comprised of participants from the following organizations: Yellowstone and Grand Teton National Parks, Caribou-Targhee National Forest, Bridger-Teton National Forest, Gallatin National Forest, USFS Regional T&E staff, Red Rock Lakes National Wildlife Refuge, Montana Fish, Wildlife and Parks, Idaho Fish and Game, Wyoming Game and Fish, USFWS consultation biologists, University of Wyoming, Montana State University, BLM, private industry and Bureau of Reclamation. The Bald Eagle Working Group began in 1981 and met twice annually from 1982 to 1995 with the goal to create management goals and objectives and facilitate research and cooperation with respect to bald eagles in the Greater Yellowstone Area (GYCC 2003). The subcommittee produced a management plan for bald eagles in the GYA in 1983, which was subsequently updated in 1995, when the bald eagle was downlisted to threatened. This management plan is likely to be used as a “Conservation and Monitoring Plan” for the bald eagle if it is removed from the threatened species list (GYCC 2003). As of 2004, Bob Oakleaf of the Wyoming Game and Fish Department in Cheyenne was the chair of the subcommittee (GYCC 2003).

Literature Cited
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U.S. Fish and Wildlife Service (USFWS). 1999. The bald eagle is back! President Clinton announces proposal to remove our national symbol from endangered species list. <http://news.fws.gov/NewsReleases/R9/A11C3CEE-AC20-11D4-A179009027B6B5D3.html>. Accessed 2004 Jun 7.

Wolff S. 2003. Bald eagle and sage grouse inventory update 2001-2003. National Park Service, Grand Teton National Park, Moose, Wyoming. 4 pp.

Grizzly Bears

Grizzly bears were listed as threatened under the Endangered Species Act on July 28, 1975 (USFWS 1993). At the time of listing, they occupied only 2% of their original range in the continental United States and numbered 800 to 1,000 individuals in five or six populations (USFWS 1993). After listing, work began on the recovery plan for the species, which was approved on January 29, 1982, with revisions made in 1993 (USFWS 1993). The primary threats to grizzly bear populations are loss of habitat due to fragmentation, and adverse bear-human interactions, which leads to the destruction of "nuisance" bears (USFWS 1993). Human encroachment into grizzly habitat is a major threat because of the bears' very large home ranges that cover 309-537 square miles for females and 813-2,075 square miles for males (YELL 2004a).

In an effort to provide information to assist with long-term management of grizzly bears in the GYE, the Interagency Grizzly Bear Study Team (IGBST) was formed in 1973. This team has representatives from the following agencies: U.S. Geological Survey, National Park Service, U.S. Forest Service, U.S. Fish and Wildlife Service, Idaho Department of Fish and Game, Montana Fish, Wildlife and Parks, and the Wyoming Game and Fish Department. The IGBST is responsible for: "conduct[ing] both short- and long-term research projects addressing information needs for bear management; monitor[ing] the bear population, including status and trend, numbers, reproduction, and mortality; monitor[ing] grizzly bear habitats, foods and impacts of humans; and provid[ing] technical support to agencies and other groups responsible for the immediate and long-term management of grizzly bears in the GYE" (Schwartz and Moody 2004). For further information on recovery goals, the IGBST and bear management activities in YELL, please consult Appendix III.

This recovery plan delineated a recovery area in the Greater Yellowstone Ecosystem that includes all or most of the following federal land units: Yellowstone National Park, Grand Teton

National Park, John D. Rockefeller, Jr. Memorial Parkway, Bridger-Teton National Forest, Shoshone National Forest, Gallatin National Forest, Caribou-Targhee National Forest, Custer National Forest, Beaverhead-Deer Lodge National Forest, and state, private and Bureau of Land Management lands in Idaho, Montana and Wyoming (YELL 2004).

Main recovery goals for the grizzly bear include: "1) average 15 adult females with cubs of the year inside the recovery zone and within a 10-mile area surrounding the recovery zone; 2) females with young occupy 16 of 18 recovery zones and no two adjacent areas shall be unoccupied; 3) known human-caused mortality is below 4% of the population estimate based on the most recent three-year sum of females with cubs minus known adult female deaths. In addition, no more than 30% of the known human-caused mortality shall be females. These mortality limits cannot be exceeded during any two consecutive years" (YELL 2004).

The IGBST website is at: http://www.nrmsc.usgs.gov/research/igbst-home.htm. An annual report is published (and available on the website) that summarizes findings from monitoring and research throughout the year. IGBST captures and collars a number of bears each year that they radio monitor throughout the year in order to track denning activity, mortality, occupancy and reproduction. Also important to understanding the ecology of grizzly bears is research on food sources, including ungulates, cutthroat trout, whitebark pine seeds, army cutworm moths and other insects, as well as their interactions with humans and the correlation between these interactions and the availability of natural food sources (IGBST 2004). In 2003, the Interagency Conservation Strategy Team—made up of representatives from NPS, USFS, USFWS, IGBST, Idaho Department of Fish and Game, Montana Fish, Wildlife and Parks and the Wyoming Department of Game and Fish—published the final Conservation Strategy for the grizzly bear in the Greater Yellowstone Ecosystem, which would go into effect if the bear is delisted in the future (USFS 2003).

Yellowstone National Park tracks bear management activities and posts annual updates on the following website: http://www.nps.gov/yell/nature/animals/bear/grizzlyup.html. The site contains information on numbers of sightings and signs reported by visitors and staff, first and last observation dates, bears that were captured, moved or euthanized, mortalities and food availability. Bear sightings reports are also posted every few weeks on the following website: http://www.nps.gov/yell/nature/animals/bear/index.htm.

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Yellowstone National Park (YELL). 2004. Yellowstone resources and issues 2004. National Park Service, Yellowstone National Park, Division of Interpretation, Mammoth Hot Springs, WY. 191 pp.

Gray Wolves

Although listed as a non-essential, experimental species under the final U.S. Fish and Wildlife Service (USFWS 1994) ruling, national parks are directed to manage wolves as a threatened species under Section 10(j) of the Endangered Species Act.

In Yellowstone, wolves have been monitored since their reintroduction in 1995 and 1996; this monitoring includes information on population dispersal, distribution, reproduction, mortality and predation of ungulates (Smith et al. 2003).

After their 70-year absence from Jackson Hole, gray wolves returned to Grand Teton National Park in the fall of 1998, when two groups from the Yellowstone reintroduction appeared. Most of the monitoring ongoing outside of Yellowstone National Park is lead by USFWS and USFS staff and consists of censusing, monitoring of reproduction and mortalities, and movement and dispersal patterns (USFWS et al. 2004). Science and Resource Management personnel at Grand Teton locate radio-collared wolves using aerial surveys and conduct ground-based observations of packs in the region from May through September (GRTE 2004). Please see Appendix III for links to reports and further information on monitoring outside the parks.

The Yellowstone Wolf Project team publishes an annual report documenting population status, pack summaries, wolf management, and research and public education efforts related to wolves in the GYE (Smith et al. 2003). This report is available through the Yellowstone National Park website at http://www.nps.gov/yell/nature/animals/wolf/wolfup.html.

The U.S. Fish and Wildlife Service, Nez Perce Tribe, National Park Service and USDA Wildlife Service collaborate on a Rocky Mountain Wolf Recovery Annual Report, available at http://westerngraywolf.fws.gov/annualreports.htm (USFWS et al. 2004). This report covers wolf populations found in three recovery areas: the northwest Montana recovery area, the Greater Yellowstone recovery area and the central Idaho recovery area, and includes information on current ongoing research and monitoring efforts in the recovery areas (USFWS et al. 2004). Wolves in the northwest Montana recovery area are classified as threatened as of 2004, with wolves in the other two recovery areas classified as non-essential experimental populations (USFWS 2004). Additionally, the USFWS publishes a weekly wolf update that can be accessed at http://westerngraywolf.fws.gov/index.htm. This report gives detailed information about specific wolf monitoring, ongoing research and management information.

Information on packs located within Grand Teton National Park can be found in both the Yellowstone Wolf Project Annual Report and the Rocky Mountain Wolf Recovery Annual Report.

Literature Cited

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U.S. Fish and Wildlife Service (USFWS), Nez Perce Tribe, National Park Service and USDA Wildlife Services. 2004. Rocky Mountain Wolf Recovery 2003 Annual Report. T. Meier, ed. USFWS, Ecological Services, 100 N Park, Suite 320, Helena MT. 65 pp.

Ecosystem Pattern and Processes

FIRE

Fire

The National Park Service Fire Effects Program provides scientific information to help evaluate prescribed fire management. Fire effects monitoring takes place at all three network parks with GRTE crews helping in BICA. At GRTE, a fire effects crew maintains a network of permanent vegetation monitoring plots in the park and surrounding Bridger-Teton National Forest. The plots follow protocols outlined in the NPS Fire Monitoring Handbook (NPS 2001)

Literature Cited
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LAND USE AND COVER

Land Cover

Derived from the early to mid-1990s Landsat Thematic Mapper satellite data, the National Land Cover Data (NLCD) is a 21-class land cover classification scheme applied consistently over the United States. The spatial resolution of the data is 30 meters and mapped in the Albers Conic Equal Area projection, NAD 83. The NLCD are provided on a state-by-state basis. The state data sets were cut out from larger "regional" data sets that are mosaics of Landsat TM scenes. More detailed information on this dataset and the Land Cover Characterization Program can be found at http://landcover.usgs.gov/. The base data set for this project was leaves-off Landsat TM data, nominal-1992 acquisitions. Development of the 1992 NLCD was started in 1995, and the goal to develop a global 1km land cover characteristics database, was met in 1997.

The next-generation product, the 2001 NLCD database, is being compiled across all 50 states and Puerto Rico as a cooperative mapping effort of the MRLC 2001 Consortium. This land-cover database is created using mapping zones and contains standardized land cover components useful for a variety of applications. Zones 21, 22, and 29 that include the parks of the Greater Yellowstone Network are less than 10% complete for the 2001 NLCD (as of July 2004). All of the available data for this and the 1992 NLCD project can be viewed online at http://gisdata.usgs.net/website/MRLC/.

The Thematic Mapper multi-band mosaics were processed using an unsupervised clustering algorithm. Both leaves-off and leaves-on data sets were analyzed. The resulting clusters were then labeled using aerial photography and ground observations. Clusters that represented more than one land-cover category were also identified and, using various ancillary data sets, models developed to split the confused clusters into the correct land-cover categories.

Literature Cited:

USGS. 2004 National Land Cover Dataset, Product Description. USGS website. (http://landcover.usgs.gov/prodescription.asp.) Accessed 7/2/2004.

LAND USE

Under construction!!

SOUNDSCAPES

Soundscape Monitoring

Winter Soundscapes are being monitored in Yellowstone and Grand Teton National Parks to determine of management thresholds selected in the final Record of Decision for the Winter Use Plan are being met. A secondary objective is to collect baseline acoustic data for park-wide Soundscape management. The primary concern is human noise created by motorized recreational vehicles. Winter recreational use zones have been delineated and assigned threshold standards for maximum decibel levels and maximum audibility (percent of time sound is audible) for human-created sounds. Monitoring of sound in the different recreation management zones began during the 2003-2004 winter use season (December-March) (Burson 2003; Burson pers. comm.).

In GRTE an additional concern is noise emanating from the international airport located within the park boundary. Year-round monitoring began in 2003 with the installation of instrumentation to measure sound at four locations surrounding the airport. Information will be gathered about the audibility and decibel levels of aircraft and other sound sources. In addition, one year-round sound monitor is installed on Signal Mountain in GRTE (Burson 2003).

Literature Cited

Burson S. 2003. Soundscape Research in Grand Teton National Park 2003-2004. November 18, 2003. National Park Service, Grand Teton National Park, Moose, WY. 9 pp.